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PATENT SPECIFICATION

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(19)

(54) CLOSABLE CONTAINERS HAVING MEANS FOR SUPPRESSING FIRE AND/OR EXPLOSION

(71) I, SECRETARY OF STATE FOR DEFENCE, LONDON, formerly MINISTER OF AVIATION SUPPLY, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to closeable containers having means for suppressing fire and/or explosion and in which there may be present in the ullage and/or at their exterior, a flammable mixture which constitutes a potential fire and/or explosion hazard.

The hazard of fire and/or explosion is invariably present where flammable gases, liquid fuels or other materials which give off flammable vapours are stored or carried in containers.

The hazard is particularly acute in the case of aircraft fuel tanks where the flash point of the fuel is low and whercin the onset of a spark or flame may result in a catastrophic explosion or fire. The hazard is present not only as a result of a flammable mixture being present in the ullage above the fuel in the tank but also because such a mixture may be present at the exterior of the tank if leakage should take place.

It is also the case that the storage of many materials, including solid materials, in containers results in conditions which constitute a fire and/or explosion hazard, examples being a flammable dust laden atmosphere above a powder material and the flammable mixture which has resulted in fire in containers holding hydraulic fluid or water/methanol mixtures.

With a view to rendering the carriage of liquid fuels safe systems have been provided in which an inert gas such as nitrogen is injected into the fuel tank ullage but such systems are complex and entail a weight and logistic penalty which is undesirable particularly on aircraft.

It is known that as flame from a burning mixture travels through a small aperture or orifice it becomes cooled and quenched due to heat transfer and absorption of the active radicals from the mixture preceding the flame front. This fact has resulted in the use of flame arrestors in the form of knitted wire and wire gauzes, but where weight is critical, and because of displacement and installation problems as in the case of aircraft fuel tanks, such arrangements are not acceptable.

U.K. Patent No. 1129894 discloses the use of reticulated foam within a vehicle tank as a means of resisting hydraulic surging of the liquid and thus reducing the shift in centre of gravity which might otherwise occur. To be effective and to offer substantial resistance to fuel surging the foam must occupy at least a substantial portion of the volume of the tank and must be secured to or so packed within the fuel tank that its movement is limited otherwise it will not be effective to offer substantial resistance to fuel surge.

It is an object of the present invention to provide a container having means for reducing the aforementioned hazard of fire and/or explosion. Such means are hereinafter called fire protection means.

A container according to the present invention has within it fire protection means in the form of a plurality of pieces of openly reticulated foam which pieces together with the void spaces within them occupy the container to an extent that there is left externally of the pieces and within the container a volume equivalent to from 10-50 per cent of the interior volume of the container, the pieces not being attached one to another or to the container.

The foam pieces may comprise balls of foam of from one to four inches in diameter which can fill the container apart from the

voids between the various balls and the voids within the balls.

The foam pieces or some of them may be additionally hollow by comprising a reticulated foam layer surrounding a hollow interior.

Various openly reticulated plastics foams may be used and must comprise material which is compatible with the contents of the container when in use and with the environment.

Also, where weight is less critical, openly reticulated metal foam pieces may be used.

It has been found that an openly reticulated cell structure bounded by skeletal strands such as can be manufactured using a polyurethane ester foam or Viton (Registered Trade Mark) foam, a mixture of the two or a nitrile foam are suitable.

An openly reticulated polyurethane ester foam having a porosity of 5-25 pores per linear inch will provide the required flame arresting properties and in the case of a liquid fuel will provide the necessary fuel flow rates. This foam material can be at least about 95% void by volume and has a density in the range of 12.0 to 30.0 Kg/m³.

In a further aspect of the invention, openly reticulated foam material as disclosed above may additionally be provided at the external surface of a container at least in the regions at which a flammable mixture may be present, and in the case of an aircraft fuel tank it has been found that a layer of openly reticulated foam having 70-100 pores per inch, at the outer surface of the tank has proved effective in suppressing fire upon fracture of the tank by incendiary means.

A container may thus have openly reticulated foam pieces within it and at its external surface.

It is an advantage of the invention that it can be applied in retrospect. For example, in the case of an aircraft fuel tank the required quantity of foam pieces or balls may simply be tipped or pushed into the tank. They can also be removed easily.

With a view to saving weight, which is particularly important in the case of aircraft, and also to keeping the loss of volume in the container due to the foam to a minimum the quantity of foam used may be reduced considerably by the use of hollow foam pieces such as hollow foam balls.

Thus experiments have shown that by the provision in an aircraft type fuel tank of hollow foam balls each of $2\frac{1}{2}$ inches diameter and $\frac{1}{2}$ inch wall thickness of polyurethane foam of 20 pores per linear inch, and which occupy at least 68% of the volume of the tank) ie there is not more than 32% tank volume space between the balls), the pressure rise in the tank following ignition of a flammable fuel mixture within the tank is consistently and reliably restricted to less than 5 lb per square inch which is an acceptable figure. The weight of foam material used in this case is more than 20% less than if solid foam balls were used.

Similar results are also obtained using the same foam material in hollow ball form of 4 inches diameter and 1 inch wall thickness.

It will be noted that to obtain the desired 68% volume of foam in the container the foam balls will have to be squashed to a limited degree.

Further squashing of the balls may give up to 90% volume foam occupation of the container but beyond this insufficient voids remain in the foam.

In all cases the nature of the foam is such as to provide free flow passages in the foam.

If a higher pressure rise is acceptable a lower volume of foam may be sufficient and the foam pieces may occupy only at least 50% of the volume of the tank if the voids in the foam are ignored.

It will be seen that if solid foam pieces occupy 68% of the volume of the tank or container and are of 97% void space foam material, only approximately 2% of the volume of the tank will be occupied by the plastics material of the foam and this will be further reduced if the pieces or some of them are hollow.

An embodiment of the invention is illustrated by the accompanying diagrammatic drawing which is a side view of a closeable container for liquid fuel partly cut away to show the interior of the container.

As shown the container 11 has an inlet filler and closure assembly 12 through which the container can be filled with fuel and an outlet connection 13 through which fuel may be pumped from the container by means not shown. The interior of the container is filled with a plurality of hollow foam balls 14.

WHAT I CLAIM IS:—

1. A closeable container having within it fire protection means in the form of a plurality of pieces of openly reticulated foam which together with the void spaces within them occupy the container to an extent that there is left externally of the pieces and within the container a volume equivalent to from 10-50 per cent of the interior volume of the container, the pieces being unattached one to another or to the container.

2. A container according to claim 1 wherein the foam pieces comprise balls of foam.

3. A container according to claim 1 or claim 2 in which some at least of the foam pieces are additionally hollow by comprising a reticulated foam layer surrounding a

hollow interior.

4. A container according to claim 1, 2 or claim 3 in which the foam pieces comprise a plastics foam.

5. A container according to claim 4 in which the plastics foam is a polyurethane ester foam.

6. A container according to claim 1, 2, 3, 4 or claim 5 in which the foam material constituting the foam pieces has a porosity in the range of from 5-25 pores per linear inch, a density in the range of from 12-30 Kg/m^3 and is at least 95 per cent voids by volume.

7. A container according to any one of claims 1 to 6 and having a layer of openly reticulated foam covering at least part of its exterior surface.

8. A container according to claim 7 in which the foam layer comprises a plastics foam.

9. A container according to claim 8 in which the plastics foam is a polyurethane ester foam.

10. A container according to any one of claims 7, to 9 and in which the foam layer has from 70-100 pores per linear inch.

11. A container having foam pieces within it substantially as described herein with reference to and as illustrated by the accompanying diagrammatic drawing.

12. A container according to any one of claims 1 to 6 and 11 and having a layer of openly reticulated foam covering at least part of its outer surface substantially as described herein.

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1 SHEET

COMPLETE SPECIFICATION

This drawing is a reproduction of the Original on a reduced scale